Chapter 56
Layer-Wise Tumor Segmentation of Breast Images Using Convolutional Neural Networks

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ABSTRACT

Early prediction of cancer type has become very crucial. Breast cancer is common to women and it leads to life threatening. Several imaging techniques have been suggested for timely detection and treatment of breast cancer. More research findings have been done to accurately detect the breast cancer. Automated whole breast ultrasound (AWBUS) is a new breast imaging technology that can render the entire breast anatomy in 3-D volume. The tissue layers in the breast are segmented and the type of lesion in the breast tissue can be identified which is essential for cancer detection. In this chapter, a u-net convolutional neural network architecture is used to implement the segmentation of breast tissues from AWBUS images into the different layers, that is, epidermis, subcutaneous, and muscular layer. The architecture was trained and tested with the AWBUS dataset images. The performance of the proposed scheme was based on accuracy, loss and the F1 score of the neural network that was calculated for each layer of the breast tissue.

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INTRODUCTION

The most common cancer in women is breast cancer, and it was the second leading cause of mortality for women in 2013. Early diagnosis and treatment of breast cancer are useful in reducing mortality rates. Two screening modalities, mammography and breast ultrasound are the popular modalities for the detection and diagnosis of breast tumor. Typically, mammography was the primary imaging tool on clinical examinations. An advantage of conventional ultrasound exams with hand-held probes is its real-time nature. During the diagnostic reviews after suspicious findings in screening, target regions can be thoroughly examined. However, in the screening setting, complete perusal takes time, and the results are operator dependent. Recently, screening exams using automated breast volume scanners are increasing. It is in general operator-independent and provides whole breast data, which facilitate double reading, and longitudinal comparison Automated whole breast ultrasound (AWBUS) is a relatively new imaging technique which was approved by the FDA in 2012 (Pellegretti et al., 2011). The AWBUS technique can depict the entire breast anatomy automatically in a 3D volume. Therefore, it may thus enable thorough offline image reading. The radiologists can check every detail of the AWBUS volume multiple times to find out potential breast lesions, and hence the hand-held scanning mistakes like missing of lesions can be possibly avoided.

Current automated breast scanners often acquire whole breast data in several separate volumes. Therefore, one patient exam can include 6 to 10 volumes with many slices, which require radiologists to spend a considerable amount of time for review. For radiologists' efficient diagnosis, the computer-aided detection system is studied. Despite the volumetric imaging advantage, the major problem that limits the popularization of AWBUS lies in the difficulty of understanding the AWBUS images. The interpretation of AWBUS images requires the knowledge of breast anatomy and ultrasonic physics, as well as enough clinical scanning experience. In such a case, the learning curve for AWBUS images can be extended. Figure1 shows the different types of layers in the breast. The epidermis layer, the subcutaneous layer, the muscle layer and the cavity layer are the four different types of layers. The decomposition of anatomic breast layers in the AWBUS images helps junior radiologists and residents for the image reading.

Meanwhile, the segmentation of anatomical breast layers can also support the computation of breast density, which is the volume ratio of breast parenchyma against all breast tissues above the chest wall. The breast density is an essential biomarker for breast cancer risk, which can be calculated by the layer segmentation of AWBUS images. In this paper, we have used a U-Net Convolutional Neural Network Architecture to implement the layer segmentation of AWBUS (Prabhakar & Poonguzhali, 2017). This network architecture has a contracting path and an expansive path, which gives it the U-Shaped architecture. The contracting path consists of repeated application of convolutions, which is then followed by a rectified linear unit and a max-pooling operation. There is a reduction in spatial information and an increase in feature information during contraction. The expansive pathway combines the feature and spatial data through a sequence of up-convolutions and concatenations with high-resolution features from the contracting path.